Polarization Reversal over Flooded Regions and Applications to Large-Scale Flood Mapping with Spaceborne Scatterometers

Son V. NGHIEM, W. Timothy LIU, and Xiaosu XIE
Jet Propulsion Laboratory, California Institute of Technology, MS 300-235
4800 Oak Grove Drive, Pasadena, California 91109, U.S.A.
Tel: 818-354-2982, Fax: 818-393-3077, E-mail: nghiem@solar.jpl.nasa.gov

IGARSS'99 TOPIC AREA: C.21 Flooding
PREFERENCE: Paper Presentation

We present the polarization reversal in backscatter over flooded land regions, and demonstrate for the first time the utility of spaceborne Ku-band scatterometer for large-scale flood mapping. Scatterometer data were collected over the globe by the NASA Scatterometer (NSCAT) operated at 14 GHz on the Japanese ADEOS spacecraft from September 1996 to June 1997. During this time span, several severe floods occurred.

Over most land surface, vertical polarization backscatter (σ_{vv}) is larger than horizontal polarization backscatter (σ_{hh}). Such polarization characteristics is reversed and σ_{vv} is smaller than σ_{hh} over flooded regions, except under a dense forest canopy. The total backscatter from the flooded landscape consists of direct backscatter and boundary-interaction backscatter. The direct term is contributed by direct backscattering from objects protruding above the water surface, and by backscattering from waves on the water surface. The boundary-interaction term is contributed by the forward scattering from the protruding objects and then reflected from the water surface, and also by the forward scattering from these objects after the water-surface reflection. Over flooded regions, the boundary-interaction term is dominant at large incidence angles and the strong water-surface reflection is much larger for horizontal polarization than the vertical one due to the Brewster effect in transverse-magnetic waves. These scattering mechanisms cause the polarization reversal over flooded regions. An example obtained with the Analytic Wave Theory is used to illustrate the scattering mechanisms leading to the polarization reversal.

We then demonstrate the utility of spaceborne Ku-band scatterometer for large-scale flood mapping. We process NSCAT data to obtain the polarization ratio σ_{hh}/σ_{vv} with colocated data at incidence angles larger than 40°. The results over Asian summer monsoon regions in September-October 1996 indicate flooded areas in many countries such as Bangladesh, India, Lao, Vietnam, Cambodia, and China. Reports documented by the United Nation Department of Humanitarian Affairs (now called UN Office for the Coordination of Humanitarian Affairs) show loss of many lives and severe flood related damages which affected many million people in the corresponding flooded areas. We also map the NSCAT polarization ratio over the same regions in the "dry season" in January 1997 as a reference to confirm our results. Furthermore, we obtain concurrent ocean wind fields also derived from NSCAT data, and Asia topographic data (USGS GTOPO30) to investigate the flooded area. The results show that winds during summer monsoon season blowing inland, which perplex flood problems. Overlaying the topographic map over NSCAT results reveals an excellent correspondence between the confinement of flooded area within the relevant topographic features, which very well illustrates the value of topographic wetness index. Finally, we discuss the applications of future spaceborne scatterometers, including QuikSCAT and Seawinds, for flood mapping over the globe.